AIRSPACE DESIGN

7

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This chapter describes the FAA's initiatives to increase airspace capacity by restructuring airspace. Airspace issues may be identified from within the FAA by air traffic controllers or by external sources, such as airlines, airport authorities, or community groups. Problems may also be identified as the result of planned changes to airports, equipment, or traffic patterns. The FAA is now working on several significant airspace initiatives, including the National Airspace Redesign Plan, the consolidation of the Washington area TRACONs, and the continuing development of area navigation routes.

7.1 National Airspace Redesign Plan

The National Airspace Redesign (NAR) will restructure existing domestic and oceanic airspace to increase its efficiency, while maintaining a high level of safety. It will consist of incremental changes to the national airspace structure, consistent with evolving air traffic and avionics technologies. The NAR will initially focus on efforts that can be implemented quickly, provide early user benefits, and set the stage for future developments. That near-term phase will extend from the present to 2002, roughly paralleling Free Flight Phase 1, the mid-term phase from 2002 to 2005, and the long-term phase beyond 2005.

The near-term National Airspace Redesign will be limited by several constraints. First, near-term changes will not include any major modifications of the NAS infrastructure or staffing, such as adding new equipment, building new runways or facilities, or hiring more controllers. Second, the redesign of sectors, routes, and traffic flows will be based on current technology. Finally, any near-term changes must have a neutral environmental impact, i.e., none will be implemented that have a negative effect on noise levels. Given these constraints, the effort should focus on the operational domain that can provide the most benefit in the shortest time. Because en route airspace is generally the least complex, the first redesign efforts will focus on that domain. Initial near-term objectives include the following:

Redesign Traffic Routes

One of the limiting factors of the NAS is that aircraft must generally follow airways that are based on a system of ground-based navigational aids. Following those airways involves flying from one navigational fix to another, connecting a series of doglegs, which increases the distance flown and the time required to do so. The basic premise of Free Flight is that modern avionics and air traffic control technologies can provide more direct routes. These user-preferred routes can be safely flown by aircraft equipped with present day flight management systems (FMS) with certified Required Navigation Performance (RNP) capabilities or area navigation systems such as GPS, and others. The NAR will redesign routes so that suitably equipped aircraft can fly more direct routes between airports.

Review the Present Route Structure and Procedures for Inefficiencies

Current procedures to separate traffic require longitudinal separation of five miles in en route airspace. When two aircraft are flying along the same airway, they are kept in trail, one behind the other, which can delay the trailing plane. If the two aircraft are heading for different airports, it should be possible for them to fly on parallel routes, maintaining safe separation, but enabling both to operate at optimal speed. The NAR will review current procedures and replace them where possible.

Redesign Sectors
Because airspace is divided into sectors that are controlled by different air traffic facilities, aircraft that are flying near or across sector boundaries may be delayed as they are handed off from one facility to another. In the future, advanced on-board navigational capabilities can be used to reduce points of congestion and the need for a large amount of coordination. Sector redesign should take advantage of this capability, which may favor the establishment of a few very large sectors, removing the constraints caused by unnecessary stratification and boundaries. The NAR will review possible redesigns and their step-wise implementation. The first step would be to establish large sectors above FL350, then gradually move the floor lower.

Redesign Traffic Flows
As part of the efforts to analyze existing routes and sectors, traffic flows should be reviewed to determine how well they serve NAS users and what workload they impose on controllers. The NAR will redesign traffic flows to increase their efficiency and to reduce controller workload. This will include the development of procedures for entering and leaving en route airspace that permit optimized climb and descent trajectories.

The completion of near-term initiatives will provide the foundation for the mid-term and long-term phases. To the extent that procedural modifications and airspace re-configurations permit optimized flight in en route airspace, the FAA will be able to reallocate air traffic control resources and personnel to the higher complexity domains, the terminal/airport and transitional control environments.

The natural progression for airspace redesign is for the mid-term phase to address the problems of the transitional control domain, where aircraft climb out of or descend to terminal airport areas, and the terminal/airport domain, where aircraft depart from or arrive at the airport. During this phase, the main areas of analysis and redesign addressed in the en route domain will be improved and gradually expanded into the higher density domains. This expansion will be enabled by technological enhancements such as the Wide Area Augmentation System, the Local Area Augmentation System, Automated Dependent Surveillance-Broadcast, Free Flight Phase 1 demonstration technologies such as the User Request Evaluation Tool, and Free Flight Phase 2 technologies such as Controller Pilot Data Link Communications.

The long-term phase will continue the evolutionary path established in the near-term and mid-term phases. It will include the implementation of additional capabilities that are described in the FAA's NAS Architecture. The NAR will use these and other technological enhancements to continue the redesign of routes, sectors, and traffic flows that began in the near-term phase.

7.2 Consolidation of Terminal Radar Approach Facilities

Terminal airspace extends from five to 20 miles from an associated airport. In metropolitan areas with several airports, the terminal airspace of adjacent airports may overlap, creating a complicated airspace structure. In these circumstances, consolidating two or more TRACONs into a single facility can simplify that airspace structure. The consolidation improves communications among controllers handling operations over a wide geographic range and increases their flexibility in merging, maneuvering, and sequencing aircraft to and from the area airports.

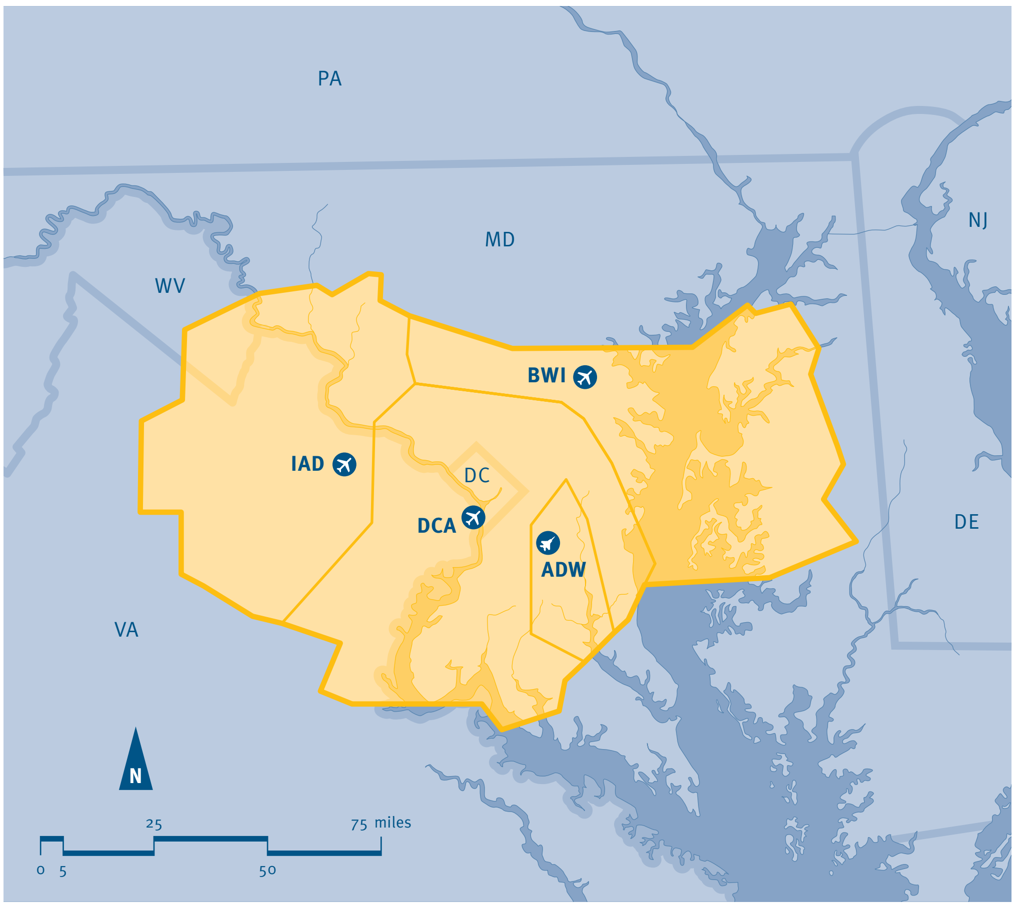
The FAA has undertaken a number of major TRACON consolidations in the past few years, the most recent being the Southern California TRACON, which combined the operations of five TRACONs in the Los Angeles-San Diego area into a single facility (Burbank, Los Angeles, Ontario, Coast, and San Diego). Other significant consolidations are planned in Atlanta, Northern California, and the Washington/Baltimore metropolitan area. The consolidation of the four Washington TRACONs provides an excellent example of the problems of complicated terminal airspace and the benefits of consolidation and airspace redesign.

7.2.1 The Potomac Consolidated TRACON

The Washington/Baltimore metropolitan area is served by four major airports: Reagan Washington National (DCA), Dulles International (IAD), Baltimore-Washington International (BWI), and Andrews Air Force Base (ADW). These four airports are close together, located within a geographic area that in many places would be served by a single airport. The existing airspace configuration of the four TRACONs is shown in figure 7-1.

Figure 7-1

Terminal Airspace in the Washington/Baltimore Area



A TRACON's airspace is subdivided into smaller sections called sectors. Each sector is assigned to an individual air traffic controller, who monitors the movement of aircraft into and out of the sector on a radar screen and provides instructions to pilots via radio. Although a controller is only responsible for aircraft in that sector, each controller within a TRACON has full radar information on all the aircraft in that airspace and can easily communicate with other controllers, as needed. However, controllers in adjacent TRACONs have only a limited ability to communicate regarding the aircraft that pass from one area to another.

In the Washington/Baltimore area, the responsibility for handing off departures from terminal airspace to the centers is assigned to specific TRACONs, based on the direction of each flight. For example, the Washington TRACON coordinates the hand-off of southbound departures from each airport's terminal airspace to the Washington en route center. The Dulles TRACON is responsible for most west and northwest jet traffic and the Baltimore TRACON is responsible for propeller traffic to the east and northeast.

Departures also need significant vectoring to sequence them for hand-off to the appropriate centers, which requires coordination among the TRACONs. For example, controllers from three of the TRACONs must coordinate each aircraft that departs southwest from BWI prior to it being handed off to the Washington center. Thus, one relatively simple procedure requires the involvement of four controllers. Similarly, arrivals also require coordination among the TRACONs. The New York and Washington centers manage arrivals to the Washington airports as a series of single streams, separating them by destination only as each flight descends into terminal airspace. But because of the complexity of the terminal airspace, more than one TRACON is usually involved. For example, some DCA arrivals from the west are routed through the Baltimore TRACON before they are passed to the Washington TRACON.

The Potomac consolidated TRACON (PCT) will combine the four area TRACONs into a single new facility. The FAA expects to commission the new facility in May 2002. Approximately one year after PCT is commissioned, the Richmond TRACON will be added to the consolidated facility. The contiguous PCT airspace will improve routing efficiency during normal operations and will also provide controllers with additional options for directing departures and arrivals during periods of adverse weather. The new PCT will permit a complete restructuring of air traffic services for the Washington/Baltimore area. The facility will be able to provide approach control functions to all area airports using a single set of procedures. Streamlined and centralized traffic management will result in the elimination of extraneous coordination and unnecessary restrictions and allow for the improvement of procedures and resectorization that is not possible in the current environment.

The consolidated TRACON, capitalizing on the availability of a new automation system to process additional long- and short-range radars, will have continuous radar coverage from south of Richmond to north of Philadelphia and from as far west as Harrisburg, Pennsylvania to east of Patuxent, Maryland. The additional terminal airspace will increase efficiency by providing more flexibility to the PCT and surrounding ARTCCs when setting up arrival and departure routes. Using terminal separation standards of three nautical miles (compared to the five nautical miles required in ARTCC airspace) and the benefits of residing in a single facility, the PCT will be able to handle inbound and departing aircraft more efficiently. The proposed airspace changes are the subject of an ongoing environmental impact study (EIS) analyzing traffic patterns and alternatives with the goal of increasing air traffic system efficiencies, enhancing the safety of flight, and reducing aircraft noise exposure to the public. The draft EIS is expected in May 2001. The new airspace design will be implemented by March 2003, approximately one year after the PCT is commissioned.

7.3 Area Navigation Route Development

Area Navigation (RNAV) refers to any instrument navigation performed outside of the conventional routes defined by the position of ground-based navigational aids or by intersections formed by two navigational aids. Technologies such as Flight Management Systems, LORAN-C, and inertial guidance systems have offered RNAV capability to aircraft for nearly two decades. With the introduction of relatively inexpensive GPS avionics in the 1990s, more aircraft are now acquiring RNAV capability. Aircraft with RNAV equipment can navigate point-to-point, eliminating the doglegs that result from using the ground-based navigational aids. The FAA is developing RNAV routes in a number of projects focused on the transition from the current ground-based navigational system to a satellite-based system. Several of these projects are described below.

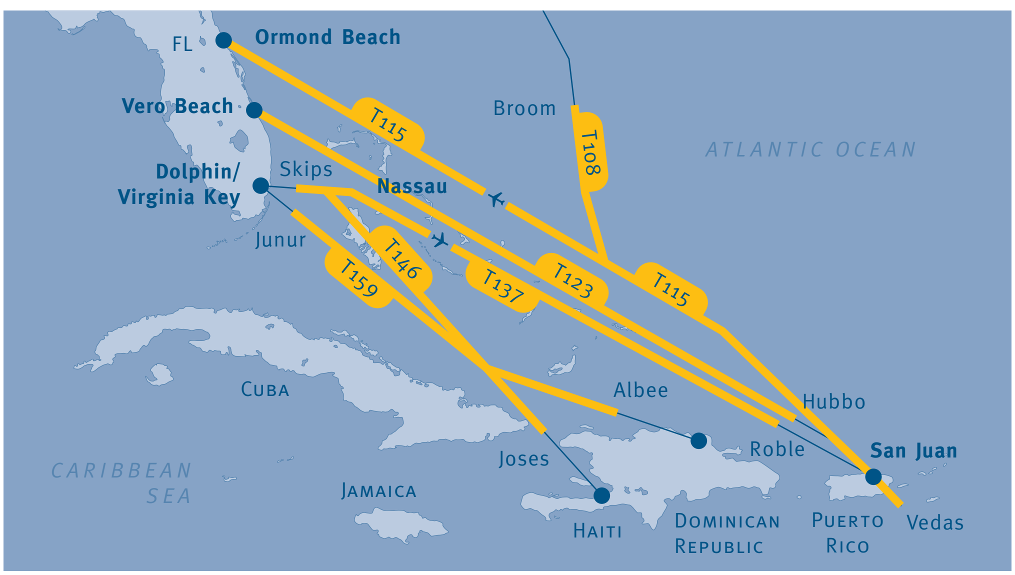
7.3.1 The Atlantic High Class A RNAV Project

Since its inception, area navigation has increased the ability of the pilots to overcome aviation system constraints in areas of limited surveillance and navigational aid coverage. The Atlantic High Class A RNAV route project (formerly the Caribbean RNAV route project) was conceived in 1995 by the Miami ARTCC and the Southern Region as an alternate means of handling air traffic in U.S. offshore Class A airspace between Florida and Puerto Rico. Air traffic in this region has been increasing steadily, but the lack of ground-based navigational aids and limited radar surveillance has substantially restricted airspace capacity. The objective of this project was to develop an RNAV route system to supplement the current airway system and to increase capacity by reducing spacing requirements.

Phase 1 was initiated in October 1997 with the implementation of 13 advanced RNAV routes. At a May 1998 project status meeting, airline participants reported fuel and time savings from using the RNAV routes. Those airlines and controllers recommended reducing the number of routes to six and realigning them, while agreeing that additional routes would be developed later. The six revised routes (referred to as "T routes") were implemented in December 1998 for use with radar coverage. The routes are eight nautical miles wide, with at least two nautical miles between parallel routes. Unlike routes based on VORs, which widen at distances exceeding 51 nautical miles from the site because of the degradation of the signal, the RNAV routes maintain a constant width, which increases available airspace capacity.

Phase 2, which extended the authorized use of the RNAV routes to times of radar outages, began in late 1999. Nine airlines are participating in this RNAV route project and seven more are expected to participate when their aircraft are properly equipped and their crews are trained. Figure 7-2 shows the coverage of the Atlantic RNAV routes.

Figure 7-2
Atlantic RNAV Routes



7.3.2 Advanced Navigation Routing Project

The FAA New England and Eastern regions are developing RNAV preferential routings to eliminate the doglegs (indirect routes) that result from using ground-based navigational aids. This project, referred to as the Advanced Navigation Routing Project, began in the New England region with the design of direct preferential routes between departure and arrival fixes and the design of overlays of existing routes. Because existing fixes were not sufficient to provide the most direct routes, the FAA developed four off-airway fixes. These fixes provide the most efficient arrival and departure points for a number of route adaptations.

The host computer software at the Boston ARTCC was also modified to enable the computer to identify RNAV-equipped aircraft so that they can be provided with the preferential routings. The host computer software modifications are being extended to ARTCCs nationwide, which will facilitate the development of RNAV routing capability across the U.S.

There are now 70 RNAV routes in the New England region, and seven test routes between the Eastern and New England Regions under development. Figure 7-3 depicts two examples of RNAV routes in the Northeast that now allow pilots to fly more direct routes between their departure and destination points. Computer modeling of 700 flight plans on the initial 36 RNAV routes indicated an average savings of one minute and five nautical miles per flight, which equates to a one percent reduction in distance and two percent reduction in time, and annual user savings of $8.2 million. Controllers reported that the test routes resulted in fewer traffic conflicts and instances of sector loading, contributing to the efficiency and safety of the air traffic system.

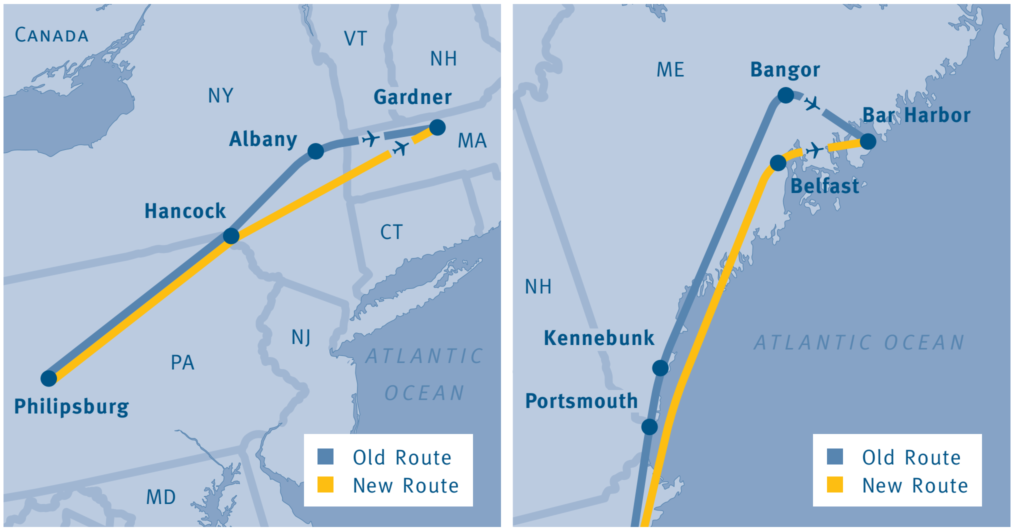


Figure 7-3
Savings from RNAV Routes

The Advanced Navigation Routing Project has expanded beyond the New England Region. The preferential routes were designed point-to-point between departure and arrival fixes or were designed to overlay an existing portion of a route to eliminate doglegs. All test routes were computer modeled. The computer simulation model determined the impact to the system and confirmed user and controller benefits. A local automation change to the Boston ARTCC's HOST computer was also developed. The HOST change identifies and segregates advanced navigation aircraft (equipment codes E, F, and G) to use HOST preferential routings not limited by surface navigation aids. Since existing fixes were not sufficient to provide the most direct routings, development of four off-airway fixes was required. These fixes help provide the most efficient arrival and departure points for over 75 terminal and en route preferential route adaptations. There are now 70 New England Air Traffic advanced navigation routings. The Eastern Region has taken the lead in expanding advanced navigation routings and there are seven test routes between the Eastern and New England Regions.

7.3.3 Southern Region RNAV Routes

A multiple-center study is underway in the FAA's Southern Region, with the objective of creating RNAV routes between Atlanta, the central Florida complex of airports (Tampa, Orlando, Daytona Beach, and Jacksonville), and Miami. Airspace in the Miami, Jacksonville, and Atlanta ARTCCs' airspace is being redesigned for use by aircraft equipped with advanced navigation systems. Ultimately, user-preferred routes will connect departure runway ends to the arrival runways via transition waypoints. In effect, RNAV departure/arrival corridors will be created to integrate aircraft to and from en route airspace.

In September 1998, departure and arrival transition way points were established for Atlanta, Daytona Beach, Jacksonville, Orlando, Tampa, and Miami terminal areas, and en route way points were established for the Jacksonville center. In September 1999, the en route portion of the RNAV routes was modeled to determine potential controller workload and possible sector redesign. The analysis found that the present sector design is adequate for the successful implementation of this project. Full implementation is scheduled for January 2001.

7.3.4 Gulf of Mexico Helicopter Procedural Initiative

In October 1998, IFR helicopter operations in the Gulf of Mexico began operations under the GPS Grid System, replacing the system that used LORAN-C and radials from shore-based VORs. The Helicopter Safety Advisory Conference, the Southwest Region Air Traffic Division and the Houston ARTCC collaborated on this project.

The previous system often took helicopters as much as 40 nautical miles out of their way, was labor intensive for controllers and pilots, and caused expensive delays (IFR delays cost the users approximately $350,000 per hour). The new system uses GPS navigation to create a Free Flight environment, resulting in substantial fuel and time savings. The use of the Grid System offers a significant capacity increase in IFR operations per hour, reduces delays, and enhances safety.